MULTIWAVELENGTH LASER PROPAGATION STUDY -- III

Quarterly Progress Report No. 4
March 16, 1971 - June 15, 1971

J. Richard Kerr

Oregon Graduate Center
for Study and Research
Portland, Oregon

July, 1971

Sponsored by

Advanced Research Projects Agency
ARPA Order No. 306

8

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Oregon Graduate Center 19600 N.W. Walker Road Beaverton, Oregon 97005	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

MULTIWAVELENGTH LASER PROPAGATION STUDY -- III

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Fourth Quarterly Report; March 16, 1971-June 15, 1971

5. AUTHOR(S) (First name, middle initial, last name)

J. Richard Kerr

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
July, 1971	3	3

8a. CONTRACT OR GRANT NO. N00014-68-0461-0001 b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) 1154-12 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT

Distribution of this document is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Advanced Research Projects Agency Department of Defense--Pentagon Washington, D.C. 20301

13. ABSTRACT

A preliminary experimental study has been made of the nature and effects of the intermittency of turbulence on the scintillation of multiwavelength laser teams. It has been concluded that the effects are substantial, and that recently-begun theoretical efforts which take the intermittency into account should be expanded. The results are sufficient to permit the definition of a possible detailed experimental study at a later date.

These results and those reported earlier are presented in a paper which is in preparation. Current measurements involve transmitter-aperture effects, which will be followed by a longer-path study of scintillation phenomena.

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6811

Unclassified
Security Classification

A-31408

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Visible atmospheric transmission						
Infrared atmospheric transmission						
Turbulence scattering						
Atmospheric scattering						

ACKNOWLEDGEMENT

This research was supported by the Advanced Research Projects Agency of the Department of Defense, and was monitored by the Office of Naval Research under Contract N00014-68-0461-0001.

SUMMARY

A preliminary experimental study has been made of the nature and effects of the intermittency of turbulence on the scintillation of multiwavelength laser beams. It has been concluded that the effects are substantial, and that recently-begun theoretical efforts which take the intermittency into account should be expanded. The results are sufficient to permit the definition of a possible detailed experimental study at a later date.

These results and those reported earlier are presented in a paper which is in preparation. Current measurements involve transmitter-aperture effects, which will be followed by a longer-path study of scintillation phenomena.

I. PROGRESS DURING THIS QUARTER

During the report period, a preliminary study was made of the nature and effects of the intermittency of turbulence on the amplitude scintillations of 4880Å and 10.6μ laser beams, using the path and equipment described in previous reports. In particular, we measured:

1) The variance of the log amplitude variance $\sigma^2(t)$, where the latter quantity was treated as a random variable. This was done for various averaging-times, at the two wavelengths.

2) The variance of the refractive index structure constant $C_n^2(t)$, treated in the same manner.

3) The time-correlation of the three above variables with each other, and their probability distributions.

4) The degree of intermittency of the microthermal fluctuations, vs. the narrow-band filter frequency (i.e., vs. the spatial scale of the fluctuations).

These determinations were done for high and low turbulence conditions, and for high and low wind conditions. In addition, the spectral covariance of log amplitude was measured for 4880Å, 1.15μ, and 10.6μ.

The results of these measurements will be presented and discussed in a paper which is in preparation. The effects of intermittency are seen to be substantial, especially under moderate or low wind conditions. It is apparent that recent theoretical efforts in this area[1-3] should be expanded. The results are sufficient to permit the definition of a possible detailed experimental study at a later date. In particular,

the effects of intermittency may help to explain certain areas of disagreement between theory and experiment,[1] and--along with the non-ideal nature of the turbulence spectrum--may explain the characteristically large spread in data points which is observed in scintillation experimentation. Furthermore, the treatment of the above quantities as stochastic variables may permit the definition of confidence-levels or bounds, which will be useful in systems design problems.[3]

II. CURRENT ACTIVITIES

The summer will be spent in measuring the effects of laser transmitter beam size and wavefront curvature (focus or divergence) on scintillations. Heretofore, all measurements on this program have been conducted with virtual point sources, for unambiguous interpretation in relation to theoretical predictions. The new transmitter-dependent results will be related to beam-wave scintillation theory in non-saturated conditions, and the effects of saturation will be ascertained.

Following this, the field site will be moved to a three-mile, flat, uniform path for comprehensive scintillation measurements at 4880Å and 10.6μ. The 1.15μ wavelength will not be utilized due to laser power and mode limitations. In particular, we expect to observe saturation at 10.6μ, and will ascertain the nature of the transverse log-amplitude covariance and receiver aperture-averaging over this longer path.

III. PUBLICATIONS AND PRESENTATIONS

The following presentation was made during the preceeding period:

J. R. Kerr, "Multiwavelength Propagation Experiments - III," Paper WB11, 1971 Spring Meeting, Optical Society of America, Tuscon, Arizona, April 5-8, 1971.

A comprehensive paper is in preparation, which will include all important results to date on this program. This paper will be distributed as a preprint and addendum to the present report. The paper has taken longer to prepare than anticipated, due to the inclusion of material on the intermittency of turbulence and its effects on optical propagation.

Following this, a further paper will be distributed and submitted for publication, describing those aspects of the instrumentation which are novel.

IV. REFERENCES

1. D. A. deWolf, RCA Laboratories, preliminary report and private communication.

2. S. Collins, Ohio State University, private communication.

3. P. M. Livingston, Naval Research Laboratory, private communication.